

upper paler, wattles blue, casque and tuft very pale brown; throat black; feet black."

"It is among the foot-hills and the adjacent plains that Guinea-fowl occur—they never range up to mid-altitude (4000 ft.).

"These birds may be seen any morning in summer feeding in large flocks out on the open fallow, well out of shot from any cover. They scatter about like farmyard hens, picking up stray corn and tasty insects, but if one turns to approach them in a gradual or unostentatious manner, they edge persistently away, and to 'gallop' them on an active pony is but to test their marvellous powers of sprinting."

No Guinea-fowl has previously been brought home from southern Arabia. The present example appears, so far as it is possible to form a conclusion from a single isolated specimen, to be referable to the typical Abyssinian race, *N. p. ptilorhyncha*, characterised by Mr. Claude Grant (Ibis, 1915, p. 26), who has made a careful study of all the races of the Tufted Guinea-fowl. The range of this race extends from Suakin to northern Abyssinia, and now, if I am correct in my conclusions, across the Red Sea to the highlands of Yemen. It is characterised by its well-feathered neck and large wattles.

XI.—*Some Reflections on the Breeding-habits of the Cuckoo* (*Cuculus canorus*). By Major R. F. MEIKLEJOHN*, D.S.O., Royal Warwickshire Regiment, M.B.O.U.

IN the ignorance which still prevails regarding many details of the breeding-habits of the Cuckoo, we have a good object lesson of how well Nature is able to guard her secrets, since, after years of careful and methodical investigation by distinguished naturalists, comparatively few authentic facts have been established.

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Theories, indeed, have multiplied exceedingly, as is inevitable when facts are few. Many of these theories verge on the fantastic, while others have been evolved by an apparent confusion of cause and effect, and facts have been twisted to fit them.

As a result, it is not difficult to understand that the Cuckoo is regarded by many people as being absolutely distinct from all other species in its habits, and as possessing many extraordinary endowments to assist it in its parasitical methods of reproduction.

The difficulties in obtaining any conclusive information on many doubtful points are, indeed, so great that it is not easy to see how they can be overcome. In addition to the initial impossibility of identifying one female from another, the male in this species unfortunately resembles his mate so closely that it can only be distinguished at a distance by the note, while its polygamous habits, and the fact that, unlike other birds, it is not more or less tied down to the vicinity of its nest, makes observation of any specific female, and a computation of the numbers resident in any district, an almost hopeless task.

Consequently, it seems that if we are ever to solve the problem it must be by a combination of lucky chances, and by carefully piecing together, as in a detective mystery, the various clues which come into our possession; and it is thus of great importance that no available information shall be overlooked or remain unknown. Hence, in this paper, I propose to review the facts we possess, and to examine some of the more important theories, in the hope of interesting others in this subject, and indicating the points on which further information is required.

The authentic facts known.

The actual facts we possess, as distinct from conclusions and theories, may be summed up as follows:—

(a) Our Cuckoo (*C. canorus*), in common with most of its family, places its eggs in the nests of other birds, leaving to them the duties of incubation and rearing the young.

(b) Either before, or when, inserting its eggs into the nest, the Cuckoo almost invariably removes one or more of those belonging to the selected foster-parents. Other eggs are occasionally ejected subsequently.

(c) The Cuckoo's egg, in the large majority of cases, is accepted by the birds on whom it is foisted, and the young Cuckoo is tended with extraordinary devotion, even after its size greatly exceeds their own. They continue to feed it for some time after it has left the nest, and, owing to its size, often have to do so by perching on its head, and thus placing the food in its huge beak. This is the more remarkable as, when fully fledged, the Cuckoo is "mobbed" by small birds owing to its resemblance to a Hawk.

(d) Very shortly after being hatched the young Cuckoo almost always ejects all the other occupants of the nest, and, in the rare event of two young Cuckoos being hatched in the same nest, the weaker is turned out. This, indeed, is a necessary provision of Nature, for, owing to its rapid growth and great voracity, there might not be sufficient food for it, if it had to be divided amongst other mouths. To achieve the process of ejection, the young Cuckoo has a curious hollow in its back, and it worms itself under each of the other occupants of the nest in turn until it has got them on this hollow, when, by a sudden straightening of the legs, it shoots them over the side of the nest. Its pertinacity is extraordinary, and it knows no rest till all are expelled, when it sinks back exhausted with gaping beak. Yet, if one of the rightful occupants be replaced its efforts begin again at once. Isolated instances have occurred in which the other young were not thrown out, and there was a case quoted on the Continent in 1914 in which two well-feathered young Cuckoos were found in a nest with young Great Titmice. But when the nest is situated in a deep hole or cavity, the "ejection" of the other inmates might be impossible.

These appear to be all the indisputable facts we possess on this subject, and, so far, the difficulties caused by the abnormal nesting-habits of this species have baffled all attempts to obtain further conclusive evidence.

The Evolution of the Breeding-habits of the Cuckoo.

Before dealing with some of the theories and conclusions which have been arrived at regarding the habits of the Cuckoo, it is, I think, of interest to consider by what process of evolution they may have originated, and whether this does not supply us with some clues to the ultimate solution of the mystery.

The Cuckoo, in reality, is by no means so unique as is commonly thought, and it is possible to trace various connecting links which form a chain, even if incomplete, between the devotion displayed by most species for their eggs and young, and the almost entire lack of this in the Cuckoo.

In this respect the Cow-birds (*Molothrus*) of America are of great interest, for in this family nearly all are parasitic, to a greater or less degree, in their breeding-habits, except the Bay-winged Cow-bird (*M. badius*), which incubates its eggs, rears its young, and occasionally even builds a nest of its own (as, indeed, do some of the Cuckoos), though usually appropriating those of other species. In this family, indeed, we seem to have a much more complete chain than in the Cuckoos, and here also one species has preserved the parental instinct more or less intact, while others have lost it to an equal extent with *C. canorus*.

Now it seems not unreasonable to assume that the first stage in the loss of the parental instinct is to be found in those species which have mainly or entirely ceased to build nests of their own but make use of the deserted abodes of other species, and thus are "parasitical" in this respect. It is worth remarking, however, that in many species which have adopted this habit a certain number of individuals still construct their own nests, and the case of an American species, *Machetornis rixosa*, is specially noticeable from the fact that at times an elaborate structure is made by the bird itself, but more usually the domed nests of other species are used.

We have, then, in these species certain individuals who have lost the building instinct, while in others it has per-

sisted, and there seems fairly conclusive evidence to show that the existence or lack of suitable deserted nests has no bearing on the matter.

Similarly, amongst such species as deposit their eggs on the ground or on rocks, with little pretence at nest-making, one finds individual cases where a more or less compact nest has been made, and the building instinct has persisted.

It may perhaps be argued from this that the loss of the "building instinct" is a very gradual process, or even that, on the contrary, in the species in question a gradual evolution towards nest-building is taking place, and it would be interesting to have reliable data as to whether the number of individuals using the deserted nests of other birds was on the increase or decrease.

The next link would appear to be the loss of the incubating instinct as evidenced in some exotic species, which leave their eggs to be hatched mainly or entirely by the heat of the sun.

Here, again, the question arises as to whether it is correct to speak of the loss of the incubating instinct, since, if birds be descended from reptiles, those leaving their eggs to be hatched by the sun, and indeed those building no nests, have remained most true to the original type; but in any case we have these stages between the parasitical breeding-habits of our Cuckoo and the care other species bestow on their eggs and young, and even if there is a wide gap between the lack of the building and incubating instincts, and entrusting the eggs and young entirely to other species, we can find the following intermediate stages to bridge this over.

First of all we have the fact that, in some species, such as the Pheasant, Partridge, and some of the Cow-birds, two or more females at times lay in the same nest. Further, we find, at times, that odd eggs are deposited by birds in the nests of others of the same or different species, presumably as a result of their own eggs having been taken before laying is completed. For instance, I have seen an egg of the Common Gull in an Oyster-catcher's nest with three

eggs, and have found five Golden Plover's eggs in a nest, one of which was obviously laid by a different female, and many other such instances are on record.

Also, judging from the behaviour of domestic fowls, it seems clear that the sight of a nest with eggs in it exercises an attraction on a bird having none of its own, when it is about to lay an egg, and if no opposition is met with. Further, in the family of the Cow-birds, the members of which seem in a curiously transitional state, we find in some species that two females often lay in the same nest, whilst one, *M. rufoaxillaris*, only selects *M. badius*—and no other species—as foster-parent.

If, then, we assume that, having by degrees ceased, more or less entirely, to build a nest of its own, the Cuckoo was unable to find suitable places in which to deposit its eggs, we can easily imagine that, by degrees, and on the analogy of the domestic fowl and other birds, it adopted the habit of placing them in the nests of other species in which there were already eggs, and also (and this is a point of considerable importance in subsequent conclusions), it may be presumed that preference would be given to such nests as contained eggs more or less similar to its own. The females adopting this habit would be freed from the exhausting duties of incubation and rearing their young, and, as occurs in those kinds of poultry in which the incubating instinct has been suppressed, would probably lay more eggs in a season, and consequently more young would be reared. The young so reared would have the parental instinct still more suppressed, and thus the practice would become hereditary.

On the other hand, we can easily imagine that the families of Cuckoos which still reared their own young would decrease rapidly in numbers, given a careless mother and nestlings requiring so much food for their rapid growth that only the strongest of each brood survived, for it seems very possible that the instinct of ejecting or starving out the other inmates of the nest was an early, or even original, trait.

In any case it has been impossible to find any abnormality in the structure of the Cuckoo to prevent its incubating its eggs. Suggestions to the effect that the hairy caterpillars on which it feeds are so scarce in some seasons that it would not have time to procure food and rear its own young, seem far fetched.

Lastly, Darwin's statement, which Dr. Rey also mentions, that "the immediate and final cause of the Cuckoo's instinct is that she lays her eggs not daily, but at intervals of two or three days," does not carry conviction with it, but appears to be confusing cause and effect.

It seems, however, unlikely that the origin of the parasitic breeding-habits of the Cuckoo will ever be definitely settled, and, having considered the question at some length, we must pass on to study the other peculiarities of this species in detail.

Dr. Rey's Conclusions.

Having exhausted our facts, the remainder of our knowledge rests entirely on theories and conclusions, and these are many and diverse. Among the most important are the seventeen arrived at by Dr. Eugène Rey *, after many years of careful investigation in Germany, and as these cover most of the main points they deserve detailed consideration.

They are as follows:—

- (1) The eggs of the Cuckoo (*C. canorus*) vary more in colouring and markings than those of any other known species.
- (2) The main distinctive features of the eggs are the greater weight of the shell, and especially its thickness and solidity.
- (3) The majority of Cuckoos' eggs resemble, in their colouring and markings, the normal type of egg of one of the common soft-billed birds. Others are of a "mixed" type, and many of these do not resemble the eggs of any known species.

* 'Altes und Neues aus dem Aushalte des Kuckucks,' von Dr. Eugène Rey, pp. viii+103. Leipzig (Freese), 1892. 8vo.

- (4) In addition to *Phoenicurus phoenicurus* (Common Redstart) and *Fringilla montifringilla* (Brambling), in whose nests the Cuckoo's egg almost invariably resembles those of the foster-parent in colour and markings, those in the nests of *Sylvia communis* (Common Whitethroat), *Sylvia simplex* (Garden-Warbler), *Acrocephalus arundinaceus* (Great Reed-Warbler), and *Acrocephalus palustris* (Marsh-Warbler), are comparatively often of the same type. In the case of all other species the resemblance is much more occasional, and apparently never occurs in the case of *Troglodytes troglodytes* (Wren), *Accentor modularis* (Hedge-Sparrow), and the genus *Phylloscopus* (Chiff-chaffs and Willow-Warblers).
- (5) A resemblance to the actual eggs in the nest does not often occur, even in the cases of the Redstart and the Brambling.
- (6) Most female Cuckoos deposit their eggs in the nests of that species by which they themselves were reared, and only entrust them to other species when forced to do so, and then only to such as build similar nests.
- (7) Most female Cuckoos deposit their eggs in nests in the same, and often rather restricted, locality.
- (8) Neither the ovary nor the development of the eggs displays any abnormality in comparison with those of other species.
- (9) The Cuckoo lays some twenty eggs each year. Possibly it is this high number which compels her to entrust them to other species.
- (10) Laying takes place on alternate days.
- (11) Normally each Cuckoo lays eggs of the same, or virtually the same, variety all its life.
- (12) Only one egg is placed in any one nest.
- (13) If two or more eggs are found in the same nest they have been placed there by different females.
- (14) The laying period corresponds to that of the foster-parents, and differs considerably in different localities, both in duration and date.

- (15) In placing its egg in a nest the Cuckoo usually removes one or more of the eggs of the foster-parent.
- (16) This often occurs a day before the egg is placed in the nest.
- (17) When placing its egg in the nest, or ejecting those of the foster-parent, the Cuckoo often has heated struggles with the owners, which frequently result in the egg being destroyed.

Assigning of Eggs to Specific Females.

Now if the above seventeen conclusions are accepted as correct we have a fairly complete history of the Cuckoo's nesting-habits. But when we review the evidence on which they are based we find they rest mainly on Dr. Rey's claim that he was able to assign each egg found to a specific female. We have, therefore, to consider first of all if this claim can be upheld.

He states that, according to the observations and experience of all oologists, it is a rule that not only the individual eggs, but also the clutches laid by each female, have a certain distinctive individuality, which can only be explained by certain peculiar conditions in the sexual organs of the female, which enable her eggs to be identified from those of all other females of the same species. Further, that when, in addition to a minute agreement in colour and markings there is also a close resemblance in shape, measurement, and weight, it becomes possible, especially in a species like the Cuckoo, whose eggs vary greatly in colouring, to differentiate between those laid by each female.

Now although great weight must be attached to the statements of such a careful and distinguished observer as Dr. Rey, and admitting that the eggs laid by each female have normally a resemblance to each other in colour and markings, I very much doubt if many oologists will support his claim to be able to assign any egg to a certain female, and this, indeed, is directly contrary to my own experience and that of others.

It is, of course, evident that if there were only two Cuckoos in a certain district, one of which laid eggs of a rufous type and the other eggs of a grey type, it would be easy to assign them to a specific female, and this would also apply to eggs having an unusual colouring, or abnormal shape due to some irregularity in the oviduct; but this is quite a different matter to Dr. Rey's claim that he could assign every egg found in a district near Leipzig to one of thirty-four different females, many of whom, from his description, laid eggs of very similar types.

I think, for instance, that most oologists would recognise the impossibility of rearranging into correct clutches a mixed assortment of eggs of the Gulls, Terns, or other species in which the colouring varies considerably, and I have often seen clutches of these eggs, clearly laid by the same bird, in which individual eggs differed strikingly. And the difficulty would, of course, be even greater in dealing with eggs of such species as the Skylark, Meadow-Pipit, and others. Nor would it be possible to visit even a small colony of Guillemots in two successive years and pick out eggs laid by the same female.

What grounds have we, then, for considering the Cuckoo an exception?

Further, it is an acknowledged fact that one or two eggs in each clutch laid by the Tree-Sparrow are distinctly paler than the others, while uniform blue eggs have been found in otherwise normal clutches of the Linnet and Song-Thrush; and, indeed, examples of variations in colour and shape amongst eggs of the same clutch are by no means uncommon, and even Dr. Rey himself points out that Walter, after seven years' experience in Pomerania, found all Cuckoos' eggs the same colour and indistinguishable from each other.

I may add that I have in my collection two Cuckoos' eggs, both taken in nests of the Hedge-Sparrow, and in a locality where I feel sure there was only one female Cuckoo, and, although these are similar in type, I do not think any

ologist would be prepared to assign them definitely to the same bird.

Dr. Rey publishes tables in support of his statement, giving details of the eggs assigned to each female, and it is interesting to analyse one or two of these:—

- (i.) Example No. 26.—Female No. 54.—Type of egg “Garden-Warbler—Lesser Whitethroat” (*i. e.* a mixed type between the two), of which eight eggs, all found in nests of the Red-backed Shrike in 1891 and 1892, vary as under in measurement and weight:—

·82" × ·63"	weight 171 grammes	(1891).
·84" × ·63"	„ 199 „	(1891).
·88" × ·65"	„ 227 „	(1892).

It is noticeable that all the eggs taken in 1892 were larger and heavier, as might naturally occur with age and distension of the oviduct.

- (ii.) Example No. 27.—Female No. 55.—Type same as above. *Eggs very similar, but larger, and the markings less profuse and finer* (the italics are mine—R. F. M.).

Three eggs taken in 1891 vary as under:—

·86" × ·63"	weight 188 grammes.
·90" × ·63"	„ 188 „

It will be observed that the first egg is *not* larger than the last one in the first example, and one cannot help wondering how these eggs could have been definitely assigned to two different females in two different years.

Again, we have the following:—

- (iii.) Example No. 58.—Female No. 6.—Type “White-throat.” Colour rather dark greyish-green, boldly clouded with grey and with many small, fine, black markings.

Variation of four eggs taken in 1878 :—

·84'' × ·63'', weight 220 grammes.

·82'' × ·65'' „ 230 „

(iv.) Example No. 61.—Female No. 23.—Type “White-throat.” Colour green, clouded with grey, and with some small black markings.

Variation of two eggs taken in 1878 and 1881 :—

·86'' × ·66'', weight 230 grammes.

·88'' × ·64'' „ 230 „

The remarks made above seem to apply equally to these two examples, and other instances in which the differences appear extraordinarily slight could be adduced.

Now even if we admit that verbal description may be inadequate to describe the small but distinct variations in egg-coloration, it still seems clear that eggs, such as the above, which Dr. Rey definitely assigns to different females, did not differ so much as those variations met with in clutches of other species.

He quotes, however, one interesting example (No. 11—Female No. 28) in the eggs of which the shape and shell-substance were abnormal, probably owing to a defect in the oviduct, and to this reference will be made later.

Finally, he quotes a case of two eggs, found by himself and his son, *with an intervening period of fifteen years*, which he describes as being so identical that no oologist could doubt the fact of their having been laid by the same bird! I am inclined to think, however, that this occurrence rather staggered him, for he appears to suggest that they may have been laid by a mother and daughter, the latter having inherited the egg-coloration.

It seems, then, that Dr. Rey's claim to be able to assign each egg to a specific female is, to say the least of it, questionable in many cases, and yet if this cannot be upheld, the strongest evidence he has in support of his conclusions Nos. 6, 7, 9, 10, 11, 12, and 13, vanishes, and any certainty regarding them is greatly decreased.

Egg-coloration.

When we proceed to deal with Dr. Rey's conclusions in detail we find that the 1st, 3rd, 4th, and 5th deal with the question of "egg-coloration," and here again we are confronted with a difficult problem, full of rather contradictory facts, which are not easy to fit into any theory, but which constitutes an important feature in the consideration of the Cuckoo's nesting-habits. And as the coloration of Cuckoos' eggs is subject to the same rules as those of other birds, a short digression seems justified.

So far as I am aware, the causes governing the coloration of eggs are unknown, though many theories have been adduced. If we assume that birds are descendants from reptiles, as there seem good reasons for doing, it follows that originally their eggs were white or yellowish-white, and, consequently, that birds laying such eggs have remained true to type, while such species as lay brightly-coloured eggs have departed most widely from it.

We may also notice that such species as lay in concealed places, like the reptiles, have, as a rule, remained true to type, while others whose nesting-habits have departed widely from those of their progenitors have also changed greatly in the colour of the eggs, possibly under the influence of the law of adaptation.

Professor Alfred Newton formed the opinion that circular markings on the egg-surface are deposited on the shell a short time before extrusion, and that, as the egg progresses through that part of the oviduct in which it receives the colouring matter, many specimens get smears or blotches, which are protracted in some direction. He therefore considered that the circular spots denote the deposition of pigment while the egg is at rest, while blurred markings occur while it is in motion, and such motion appears to be forward and rotary, often producing spiral smears. And as, on nearly all occasions, the larger end is protruded first, it is, as a rule, the more heavily marked; but when, as sometimes occurs, the reverse is the case, the small end is

the more heavily marked. The markings lying deep in the shell, and the ground-colour, are due to some earlier dyeing process, probably due to bile-matter.

This, however, does not solve the difficulty of the various colours which so often occur in eggs of the same species, such as the Cuckoo, Guillemot, Tree-Pipit, Gulls, and Terns, nor does it explain the occurrence of a rufous or pink type in eggs of the Blackcap, Dartford Warbler, and other species.

Dr. Rey and others, dealing with the Cuckoo, have adduced the theory that the food supplied to the young, which differs with the foster-parents selected, has an influence on the future egg-coloration; but this seems an untenable, though ingenious, solution. For if young birds be removed from the nest at an early age and fed on more or less artificial food, no alteration in the colour of their eggs occurs, and the Canary, after generations of rearing on foods which must differ from those eaten in a natural state, and, more remarkable still, after the type of plumage has been greatly changed, still continues to lay eggs of the original type. Nor is it difficult to recall other instances to show that this idea, though attractive, only illustrates the tendency to fit facts to suit theories, for, if true, it would elucidate the mystery of the varying colourings of Cuckoos' eggs.

In some instances it seems possible to trace a connection between egg-coloration and locality. It is noticeable, for instance, that eggs of the Common Guillemot from many colonies show a distinct predominance of a certain coloration such as a white, yellowish, or deep blue ground-colour, and in a certain locality in the Midlands I observed that the majority of eggs of the Garden-Warbler were of an unusually pale type. On the other hand, a visit to a colony of Gulls or Terns at once disposes of any attempt to make this a general rule, and the only possible deduction may be that certain families laying eggs of a given type may have established themselves and flourished in such localities.

All the facts in the problem are very conflicting, and only the following general rules can be stated:—

- (a) Birds nesting in holes, as a rule, lay white eggs. (The converse, however, that all birds laying white eggs nest in holes is by no means so true.)
- (b) When the plumage of the female harmonizes with the surroundings of the nest, the eggs have a protective coloration, and this is usually the case with birds nesting on the ground.
- (c) Where both sexes are brightly coloured the eggs are usually laid in concealed places and are not handsomely coloured.
- (d) Many species laying whitish eggs in places exposed to view cover them over when leaving the nest.

It seems very doubtful if the problem of egg-coloration will ever be solved, and it may be that food, climate, and "strain" all exercise an influence, as is probably the case in the human race. It might throw some light on this if we knew whether clutches of a given species, taken in high latitudes or altitudes, showed any constant variation from others taken in more southern climes. It seems possible that the process of evolution and the change in the nesting-habits of many species owing to the changing conditions of civilization would produce varying types of egg-coloration, while the law of adaptation would ruthlessly eliminate any progression beyond a certain limit, and, consequently, variations in type would persist so long as they did not contravene this law. Further, such individuals or families as laid eggs less well adapted in colour to the requirements of protection or only suitable to certain localities, would remain in a minority, as is perhaps the case with those individual Blackcaps, Rock-Pipits, and other birds which lay eggs of a rufous or distinct type.

But in the case of the Cuckoo, where there is a large choice in nesting localities and a wide range in suitable egg-coloration, a greater number of families laying differently coloured eggs than in other species would have survived.

Coloration of Eggs of the Cuckoo.

We now pass on to the concrete case of the coloration of the eggs of the Cuckoo, which is dealt with in the 1st, 3rd, 4th, and 5th of Dr. Rey's conclusions, and the facts we have to work on are as follows:—

(a) Dr. Rey, after exhaustive investigation, shows that the legendary resemblance of Cuckoos' eggs to those of the birds in whose nests they are placed is much exaggerated. He produces tables showing a comparison of 597 Cuckoos' eggs with those of the 15 different species in whose nests they were deposited.

Of these:—

- 180 or 30·2 per cent. resembled the eggs of the foster-parent.
- 164 or 27·5 per cent. resembled the eggs of other species at times selected as foster-parents.
- 209 or 35 per cent. were of a "mixed" type, intermediate between the eggs of two species.
- 44 or 7 per cent. were of a distinctive type of their own.

Further, of the first 180 only 76 exactly resembled the eggs of the actual clutch with which they were found, and of these 57 were in nests of the Common Redstart. The remaining 104 were unmistakably *of the same type* as those of the foster-parents, but were *distinct from the actual clutch* with which they were found. Hence we find that Cuckoos' eggs exactly resembling those of the nest in which they are found only amount to 13 per cent., while those resembling the general type of the species selected are about 45 per cent.; but the number of species they resemble in type is limited, and, according to Rey, mainly comprises the Redstart, Brambling, White Wagtail, and the Garden-, Reed-, and Marsh-Warblers. His observations, however, were made on the Continent, and in Britain the species they mostly resemble are probably the Meadow-Pipit and the Sedge- and Reed-Warblers.

(b) In some districts on the Continent the eggs of the Cuckoo are almost invariably of the same type as those of the most abundant species, and consequently that which is most often selected as foster-parent. Amongst many eggs recorded by Rey from the Dessauer Heide and northern Finland not a single one differed from the Redstart type, and in these localities that species is almost invariably selected as foster-parent; whereas in Lapland, where the eggs are practically always deposited in nests of the Brambling, a very large percentage resemble the type of that species. Further, according to "Westfalen's Thierleben" (ii. 20), Cuckoos' eggs from the moors of Oldenburg always resemble the type of the Meadow-Pipit, the usual foster-parent in that locality.

(c) In other localities, on the contrary, Cuckoos' eggs are often found in the nests of species they *never* resemble, such as those of the Wren or Willow-Warblers. Walter found over 150 specimens in nests of the Wren, yet, according to his observations, this species, and the Willow-Warblers also, invariably desert their nests in consequence, as the Cuckoo in depositing her egg enlarges the entrance-hole and damages the nest.

(d) In Britain the Hedge-Sparrow is frequently selected as foster-parent, and the eggs are, as a rule, successfully hatched. Yet Cuckoos' eggs found in the nests of this species are never blue, and Rey says this is also the case on the Continent.

(e) The eggs of the Cuckoo vary more in colour and markings than those of any other known species. The ground-colour ranges from white, yellowish, greyish, or violet-grey, to greenish, bluish, brownish, reddish, etc., and the markings, which at times are clearly defined, or at times shade into the ground-colour at the edges, are blotches, spots, or scrolls of black, brown, yellowish, ashy-grey, reddish, reddish-brown, violet, greyish-green, etc. As a rule they are most profuse round the larger end and form a zone. Some specimens are uniform bluish-green or blue, with, at times, a few faint spots of rusty-red.

(f) Generally speaking, by far the most complete resemblance in colour to the eggs of the foster-parent occurs in the case of foreign species of Cuckoos, which deposit their eggs in the *open nests* of species nearly related to each other.

(g) In Germany, however, the most complete similarity in the eggs of *C. canorus* most often occurs when the eggs are placed in the nest of the Common Redstart, a species which breeds *in holes*.

Such curiously contradictory facts have, needless to say, produced very varying theories.

The general consensus of opinion, including such authorities as Baldamus, Rey, Professor Newton, and others, favours the theory that the Cuckoo, whenever possible, deposits her eggs in the *nest of that species by which she herself was reared*, and that, provided sufficient nests of such species are available, this habit is transmitted to her posterity and we have what are termed "Hedge-Sparrow Cuckoos," "Meadow-Pipit Cuckoos," etc.

It is also a generally accepted fact that each female Cuckoo lays eggs of approximately the same type all her life.

After this, however, the theories diverge rather widely. Baldamus, in 1853 and 1854, explained the resemblance of the eggs of the Cuckoo to those of the foster-parents by concluding that the Cuckoo, whenever possible, deposits her eggs in the *nests of those species whose eggs most resemble her own*, and only selects others when it is not possible to find such nests.

This was opposed "*in toto*" by Adolph Müller, who considered it the exception for any resemblance to occur, but his facts and arguments are neither numerous nor convincing. He states that the species selected as foster-parents will not only incubate eggs of a totally different colour to their own, but even bits of lime. Yet, later on, he quotes the cases of a Yellow-Hammer and Whitethroat who ejected the Cuckoo's egg, presumably, he says, because they detected

the fraud, and hence deduces that they *can* distinguish strange eggs—a curious contradiction! He is also, by the way, responsible for the story that, according to the evidence of a Kaufmann Kiessel, a Cuckoo at St. Johann on the Saar incubated two of its own eggs and reared the young—a statement Rey rightly refuses to accept.

Künz then advanced the startling idea that the eggs in the nest of the foster-parent produce such an effect on the female Cuckoo that she lays an egg of the same colour!

Rey and Wasnam enunciated the theory, already discussed under “Egg-coloration,” that the food supplied to the young Cuckoos by their different foster-parents influences the subsequent colour of the eggs they lay. They argue that, in certain more or less restricted areas, as distinct from whole countries or wide expanses, the resemblance of the Cuckoo’s egg to those of the foster-parents is an almost invariable rule; in other localities it frequently occurs, while in others again it is quite the exception, and this latter is especially the case near large towns, where the original distribution of birds has been interfered with by the progress of civilization, resulting in many species becoming rarer or ceasing to breed there. As a consequence of this, the Cuckoo is unable to find a sufficient number of the nests she prefers and has to use others.

Hence it follows that, if a female Cuckoo lays eggs of the same type all her life, there will be an insufficiency, in such localities, of the nests she requires, and thus eggs of, say, the Whitethroat type will be found in nests of the Red-backed Shrike, etc. Dr. Rey then draws the conclusion that the more exclusively the Cuckoo entrusts her eggs to any one species the greater is their similarity, and, conversely, the greater the number of species selected by different females the less is the resemblance.

Rey also agrees with Baldamus that, when possible, the Cuckoo deposits its eggs in the nest of that species by which it was reared, and that consequently a resemblance in egg-coloration results from the repeated rearing of many generations by the same foster-parents. If, then, as he

argues, the food supplied to the young Cuckoo influences the subsequent colour of the eggs the problem is solved, and "mixed types" of eggs and variations are easily accounted for by the Cuckoo being unable to find sufficient nests of the species that reared her, and being forced in consequence to entrust her eggs to others. For instance, if a female Cuckoo, reared by a Whitethroat and laying eggs of that type, were forced to deposit her egg in the nest of a Garden-Warbler, the young Cuckoo, if a female, would lay eggs of a "mixed" type.

But, as already pointed out, there are strong arguments against this theory, and it is not easy to accept.

Boraston refers to the theory that when the eggs of the Cuckoo resemble those of the foster-parent they are hatched, and that thus the strain of birds laying such eggs becomes "naturally selected," and that, when the resemblance does not exist, the eggs are not hatched and the strain gradually becomes eliminated. He argues, however, that, if this were so, the foster-parents would themselves become the "natural selectors," and that to make them responsible for "selecting" a type of Cuckoo's egg resembling their own and thus deceiving their posterity, is an untenable theory. Further, after examining 76 nests of 31 different species containing Cuckoos' eggs, he comes to the conclusion that the alleged specialization into types resembling those of the foster-parents shows no constancy, and that the difference between eggs deposited in nests of the same species is just as great as between those laid in nests of different species.

Professor Newton argues that assimilation in colour is unnecessary in the case of the Hedge-Sparrow, but that, since other species are more particular in accepting differently coloured eggs, assimilation to their types is more requisite, and that the operation of natural selection in egg-coloration would be most needed in those cases in which the foster-parents are not easily duped—that is in the cases occurring less frequently. And it is in such cases that it is found, since eggs deposited in nests of the Red-backed Shrike, Redstart, Buntings, and Icterine Warbler resemble those of

these species: yet, in comparison with other birds, their nests are rarely used.

Boraston, however, comments on this—that, if so, it was by a more rigorous application of natural selection; that is, by refusing to hatch any Cuckoo's egg that did not closely resemble their own, these four species eliminated all would-be patrons except those laying eggs so like their own as to escape detection, and that, in consequence, only these four strains were preserved. He then adds that such a theory will hardly bear examination.

If, then, we reject the conclusions of Rey and Wasman, the question arises as to what theory we can substitute which will fit our facts. We are, I think, forced to admit that the resemblance in the colour of Cuckoos' eggs to the types of those of the foster-parents selected is not merely accidental, arising from the great differences in coloration, but that there is some fundamental law which Nature has ordained to give them the advantage of protective coloration.

It has always seemed strange to me that all the authorities, so far as I know, have accepted the idea that the nest is selected *before* the egg is laid, but this is probably due to the fact that eggs of the foster-parents are occasionally removed the day before the Cuckoo deposits its egg in the nest. Yet, as Dr. Rey points out, it does not necessarily follow that the Cuckoo deposits its egg in another nest *on the day on which it is laid*, though had the nest been already decided on there seems no reason why this should not be done.

I personally think that the main point in the problem is whether the Cuckoo selects a nest *because the eggs in it resemble her own*, or whether the fact of one particular species being selected for several generations has any effect on the egg-coloration, and I consider the former is far more likely to be correct. The latter assumption, as has been pointed out, presents many difficulties, whereas the former would appear to solve them.

This idea was, indeed, first started by Baldamus, and

Wasman even admits that the eggs in the nest probably afford the female a clue in identifying the species that reared her; and other authorities are of opinion that the Cuckoo, when possible, deposits her eggs in the nests of the same species that reared her. My own theory goes further than this. I think it is only natural to assume that each Cuckoo lays eggs of the same *type* all her life, and it is probable that the egg-coloration is transmitted, more or less exactly, from mother to daughter, and thus there are families or "strains" of Cuckoos laying eggs of a certain type. It is possible that the male may influence the egg-coloration, but this seems unlikely.

Now we may assume that Natural Selection would favour those Cuckoo families whose eggs most nearly resembled those of the foster-parents, and hence, for example, Cuckoos laying blue eggs would become numerous in districts where the Redstart was common, while it is obvious that if such coloured eggs had to be placed in the nests of other species they might frequently be rejected, and, consequently, this family would either die out by degrees or migrate to some other district where they could find eggs resembling their own. If this theory be correct it would, I think, produce the following results:—

- (1) Cuckoo families laying eggs of a very distinctive coloration would either become very localized in districts where suitable foster-parents existed in sufficient numbers or would gradually die out.
- (2) Cuckoos laying eggs of a more neutral colour and more nearly resembling the types of the species most suitable as foster-parents would become far more numerous, since they would have a wider choice of nests in which to deposit their eggs, and the colour would be a protection.
- (3) Cuckoos laying eggs of the Wren or Willow-Warbler type would become very rare, since when their eggs were deposited in the nests of these species they would not be hatched, and, if placed in other nests, a large proportion would also not be accepted.

Now if we refer to the facts we possess regarding the coloration of Cuckoos' eggs (pp. 198-200), we find that the first of these suppositions is confirmed by (*b*) and the third by (*c*), and the fact that Cuckoos' eggs of this type are seldom met with. The preference of parasitic species for "domed" nests has been called attention to in reference to the Cow-birds, and when other nests with suitably coloured eggs were not available, the tendency might be to use "domed" ones. Our second supposition is supported by general experience, and the only two facts that present any difficulty are (*d*) and (*g*).

The latter, however, is not difficult to fit in, since although the Redstart nests in holes, it is evident that when the female Cuckoo can insert her egg she can also see the colour of the others. Fact (*d*) is certainly curious, though Dr. Rey's statement, referred to previously, that eggs of the Hedge-Sparrow type do not occur is hardly correct, since those of the Redstart type, which are virtually the same, certainly do. Yet the fact remains that the Hedge-Sparrow is a common foster-parent, but eggs found in the nests of this species seem never blue! Possibly this may be due to the fact that this bird is very common; its nests are not usually well concealed and may be found practically throughout the nesting-season. The Cuckoo may know by instinct that the Hedge-Sparrow will accept eggs of any colour, and consequently uses it as a "makeshift" when other suitable nests are not available.

This explanation, it must be admitted, is unsatisfactory, and undoubtedly this particular evidence seems to point to the conclusion that it is the foster-parents or the nest, and not the colour of the eggs, that influences the Cuckoo in her choice; yet such a theory is more difficult to fit in with our other facts.

And moreover, if the theory regarding the connection between food and egg-coloration were correct, blue Cuckoos' eggs would be common in Britain, and this is not so!

I have, on occasions, experimented in localities where the

Cuckoo was laying, by rather exposing to view nests of the Hedge-Sparrow, and making the owners desert, and then leaving an incomplete or complete clutch in the nest for some time, but I have never obtained a Cuckoo's egg in such nests.

Possibly the nest and the foster-parents by which she herself was reared may both have some effect on the Cuckoo, and we may suppose that, if she cannot find a nest in which the eggs resemble her own, she then places her egg preferably in the nest of that species by which she herself was reared.

My view is that the Cuckoo, whose whole nature seems careless and improvident, lays her egg in some suitable spot and also very often leaves it there, with perhaps a second or third laid subsequently, and then commences a search for nests in which to deposit them. In any case, after laying her first egg the Cuckoo would be able to recognise the eggs of other species which resembled her own more or less closely, and this would explain the large proportion of the eggs which resemble the general type of those of the foster-parent. Those that do not, are presumably due to inability to find a suitable nest.

It seems to me far more likely that the Cuckoo is influenced by the colour of the eggs in the nest more than by the actual nest itself or the birds to which it belongs, though it seems possible that she would be attracted by the locality and surroundings in which she herself was reared, and would seek nests in a similar place.

Moreover, one may conclude that, to avoid causing alarm and being "mobbed" she would endeavour to examine the selected nests while the owners were away and thus might not see the foster-parents, in which case she could not be influenced by them.

The main point, therefore, on which further information is required seems to me to be whether the nest is selected *before* or *after* the egg is laid, and this is exceedingly difficult to obtain.

I can only quote two instances from my own observations which seem to throw any light on the subject :—

(i.) In 1909 I was staying for three weeks, at the end of May and in early June, in a locality in the Midlands where Cuckoos were very plentiful. Early one morning I saw from my window two Cuckoos, clearly a male and a female, settle on the bough of a high elm close by, and, shortly after, the female waddled down the bough to a fork in the main stem, near the tree-top, and was lost to view in the foliage. The male then flew off, calling repeatedly, but the female remained some time before leaving. From the behaviour of this pair I have a very strong suspicion that an egg was laid in the tree-fork, and have always regretted that I was unable to investigate this, though I am convinced there was no nest of any other species near this fork.

(ii.) About the same time (the second week in June) I found a Sedge-Warbler's nest, which had been robbed, and passing this again some five or six days later I found to my surprise that it contained a Cuckoo's egg, and this egg, which is in my collection, has a *greenish discoloration* round the smaller end, exactly similar to that which occurs when eggs are left lying for some time on damp moss or grass.

Now I think it is clearly unlikely that the Cuckoo selected this nest before laying her egg, and though it may be argued that the nest she had selected was destroyed, my view is that, having laid her egg, she failed to find a suitable nest, as the Sedge-Warblers were all sitting or had young, and the Reed-Warblers had not commenced to lay, and, not caring to leave her egg any longer, she deposited it in this nest to take its chance.

It is unfortunate that, as regards the period at which the nest is selected, there is no reliable information about the Cow-birds, and though Major C. Bendire, of the United States National Museum, holds the view that the nest is chosen before the egg is laid, he apparently has no definite reasons for this theory.

Finally, I may add that I do not for a moment suggest that the Cuckoo carries her egg with her till she finds a suitable nest, as this might entail a protracted journey. But I think that she lays it in some concealed spot on the ground, or in a tree-fork, and leaves it there until she has found a nest in which to deposit it.

The Distinctive Features of Cuckoos' Eggs.

Passing on now to Dr. Rey's second conclusion, the distinctive feature of the Cuckoo's egg, as he states, is the comparatively greater weight of the shell in proportion to the size, its greater thickness, and different grain. The colouring in many instances gives no clue, though Dr. Rey says that the markings of most Cuckoos' eggs vary distinctly as regards the sides opposite each other, and that small, distinct, round, blackish spots are a common characteristic.

Nor does the size afford any clue, the measurements of 625 eggs by Dr. Rey giving the following results :—

Maximum : $1\cdot00'' \times \cdot70''$ or $\cdot98'' \times \cdot72''$.

Minimum : $\cdot78'' \times \cdot61''$ or $\cdot80'' \times \cdot59''$. (A measurement of $\cdot81'' \times \cdot57''$ is also recorded.)

Average : $\cdot88'' \times \cdot64''$.

As regards weight, however, resulting from the greater thickness and strength of the shell, we have the following comparison with eggs of the Red-backed Shrike and Crested Lark, which are almost identical in size :—

	<i>Maximum weight.</i>	<i>Minimum weight.</i>	<i>Average.</i>
	grammes.	grammes.	grammes.
Red-backed Shrike	212	148	186·5
Cuckoo	325	165	232
Crested Lark	230	150	191·7

It is of interest to note in this connection that the eggs of the Cow-birds are also stronger in shell than those of other similar species, and vary greatly in colour and shape.

They hatch in ten or eleven days, and thus the young have an advantage in this respect over those of their foster-parents, and this, with their larger size and rapid growth, enables them to obtain all the food, and the other inmates of the nest, or the weaker Cow-birds, die of starvation. Also the germ in the egg possesses extraordinary vitality and remains alive even if not incubated for a long period, and this may be the same in the case of the Cuckoo.

As a general rule, then, Cuckoos' eggs can be identified satisfactorily from those of the foster-parents, though abnormal eggs of other species are to be found in collections labelled as those of Cuckoos; and some of these might on occasions pass as such, even with experts, when larger size and abnormal shell-thickness occur together which, however, is seldom the case. The shell of the Cuckoo's egg is smooth but not glossy, and its relatively small size and thick shell are admirable provisions of Nature to enable it to be carried in the beak and deposited in the nests of other species.

How many Eggs does a Cuckoo lay each year?

Leaving Dr. Rey's 8th conclusion for the present, let us consider the 9th and 10th, in which he says that each female lays some twenty eggs each year, and that laying takes place on alternate days.

This, of course, is again based on his claim to be able to assign every egg found to a specific female, and, as already stated, I think this very questionable.

Most authorities estimate the number at from five to ten, and in the case of the Cow-birds eight to twelve is the general opinion, though Major Bendire says that probably several days elapse between the laying of each egg, and that the laying season appears to last two months.

Dr. Rey's claims in support of such a high number do not seem convincing. He quotes a Captain Krüger-Velthusen in Brandenburg as giving the number of eggs laid each year as twelve to seventeen, but seems to admit that the observations of Walter and others did not produce

such a high estimate, and then supports his own theory as to the laying on alternate days by tables, but expressly states, which I consider of importance, that in most cases *there is no proof that an egg is laid on the same day that it is found in the nest*, but that it may have been laid *from one to several days previously*.

This, incidentally, rather supports the theory that the nest is selected after the egg is laid, for, if before, there seems in many cases no reason for the delay. As regards Dr. Rey's tables, it will be sufficient to analyse four to see how he arrives at his conclusions.

(a) Six eggs of female No. 8 were found as follows:—Two on the 5th of May, one on the 8th of May, and one on the 10th, 15th, and 16th of May respectively.

Allowing the two days' laying period, which he considers correct, Dr. Rey suggests these eggs were laid on the 3rd, 5th, 7th, 9th, 11th, and 13th of May.

(b) He states:—In some twenty cases my son succeeded in establishing the fact that the eggs had actually been laid on the day they were found. Thus, on the 20th of May, 1891, he found two Shrikes' nests close to each other, one containing four eggs of that species and the other being empty. The following day the first nest contained two Shrikes' eggs and a Cuckoo's egg of female No. 37. On the 23rd of May the second nest contained a Shrike's egg, and also a Cuckoo's egg of the same female. Thus the first egg must have been laid on the 21st and the second on the 23rd of May.

The conclusion is not clear!

On both the 27th and 29th of May Dr. Rey found other eggs of this female, and states he was able to establish the fact that a fifth egg, found on the 31st of May, was laid on that day, *because the previous day it (the nest) had only contained Shrikes' eggs*.

Other eggs, attributed to this same female, were found on the 4th, 12th, and 18th of June.

Now, so far as I am aware, in such cases there are no means of telling whether an egg found in a nest has been

laid on any given day, and, since Dr. Rey himself admits that eggs may not be deposited in nests on the day they are laid, it is difficult to see on what his conclusions are based.

(c) He then, however, quotes the interesting instance, referred to on p. 197, in which the eggs of a female were abnormal, probably owing to a defect in the sexual organs, and as, in this case, it is clearly possible to assign them to a definite bird, the tables he gives are worth close study.

5	eggs	were	found	in	1889	on	the	30th	of	May	and	the	7th,	14th,	25th,	and	26th	of	June.					
8	"	"	"	"	1890	on	the	22nd,	23rd,	and	29th	of	May	and	the	3rd,	5th,	8th,	and	12th	of	June.		
9	"	"	"	"	1891	on	the	14th,	<i>20th,</i>	<i>26th,</i>	and	<i>28th</i>	of	May	and	the	3rd,	9th,	12th,	16th,	and	<i>19th</i>	of	June.
7	"	"	"	"	1892	on	the	<i>24th</i>	and	<i>26th</i>	of	May:	<i>11th,</i>	14th,	15th,	and	<i>27th</i>	of	June	; and	the	1st	of	July.

Dr. Rey states that the eggs found on the dates in italics were laid on these precise days, and that all the eggs were in nests of the Red-backed Shrike.

Now it will be seen that the highest number of eggs found in any one year was *nine*, and yet it may be assumed that the locality was well searched. Also, an examination of Dr. Rey's tables shows that only in one instance (referred to below (d)) were more than nine eggs of the same female found in any one year. He accounts for this by the many eggs he considers get broken and destroyed; still it is hard to find in the tables any indication of such a high number as twenty for a female in a year, and it must be assumed that Dr. Rey and his son made every endeavour to find all the eggs. The dates, too, show curious changes and intervals, and seem to dispose of the theory that the eggs are laid at any regular periods, or in two clutches, as in the case of other species; but, naturally, once the Cuckoo adopted parasitic habits the necessity for this would cease.

(d) Finally, we have the one case, referred to above, in which more than nine eggs were found in a year, as Dr. Rey claims to have discovered seventeen, all of which he could assign to "No. 33—Female No. 52" between the 21st of

May and the 5th of August, 1891. But the type of these eggs does not appear to have been a distinctive one, and is described by him as a mixture between *Motacilla* and *Sylvia*, with a dull greenish-yellow ground-colour, and markings of greyish-brown over the whole surface, and a wide zone round the larger end; and as both the weight and measurements varied to some extent, they may have been laid by two females, or a mother and a daughter. Indeed, the general evidence as to the number of eggs laid yearly and the intervening periods seems to me very slight.

Dr. Rey concludes that many eggs get destroyed, and quotes instances of having found broken shells under nests or eggs built into the lining of nests. It is also stated that, in the case of the Cow-birds, many eggs do not hatch, some being placed in deserted nests, others in nests not laid in—which are consequently abandoned, while some are even dropped on the ground by the female, which appears to be even more careless than the Cuckoo.

We also know that among such kinds of domestic fowls as do not incubate their eggs, the tendency is to lay a far greater number.

Further investigation is much needed and might be most successfully carried out where the Cuckoo is scarce and only one or two females are found; but unfortunately this usually occurs in wild expanses where the Meadow-Pipit is numerous, and it is almost impossible to find all the nests of this latter species.

From my own observations in districts where the Cuckoo was both very numerous, and also limited to one or two pairs, the number of eggs and young found have never led me to suppose that more than nine or ten eggs were laid annually, even allowing for a good percentage of breakages and eggs not discovered, and I doubt if the number of eggs destroyed is as large as Dr. Rey supposes.

Also, the evidence seems to me to indicate that the eggs are laid at irregular and varying intervals. The Cuckoo is believed to be polygamous, and hence the laying of eggs may depend on the presence of the males. With the Cow-

birds, the majority of which are polygamous, the males are said to outnumber the females by three to one, possibly for this reason, and the laying season is thought to last two months, but I know of no data to suggest that in the Cuckoos the males are more numerous than the females.

Dr. Rey's remaining Conclusions.

As regards Dr. Rey's remaining conclusions, there seem no special grounds for comment. It may, I think, be accepted from his data and general information that each Cuckoo deposits its eggs in a restricted locality and probably returns to the vicinity in which it was itself reared, and the data given regarding the female which laid abnormal eggs seem to establish this, and also the fact that each Cuckoo, whenever possible, selects nests of the same species, the two exceptions in the case of the above-mentioned female being the last eggs found on the 26th of June, 1889, and the 12th of June, 1890, when presumably no such nests were available.

Also, as stated in conclusions 12 and 13, it is quite the exception to find more than one Cuckoo's egg in any nest, and Dr. Rey states that, out of 1246 clutches with Cuckoos' eggs reported to him only 49 had two eggs. In one case three eggs were found in the nest of a Robin and in another case three in the deserted nest of a Wagtail, but in both cases the eggs were of quite different types, and clearly laid by different females.

An exceptional case, however, is quoted from Thuringia, where a Red-backed Shrike's nest found on the 18th of May, 1891, contained two eggs of this bird in it and two of the Cuckoo, and as the latter were practically identical in colour, markings, and size, and also, together with another egg found on the 25th of May, were deformed in shape owing to some peculiarity in the female, there is no doubt that they were laid by the same bird. Such cases, however, are very rare, and seem clearly due to a shortage of suitable nests in the locality in question.

Here, again, the often referred-to Cow-birds differ, since from one to seven eggs of some species are found in the same nest, two or more being probably laid by the same bird.

There are also no grounds for doubting the correctness of Dr. Rey's conclusion that the laying period varies greatly in different localities, both in date and duration, and corresponds with that of the species selected as foster-parent, though it is not so easy to reconcile this with his view that each female lays some twenty eggs yearly, since, if laid on alternate days, this means forty days out of a possible period of some three months.

Finally, as regards his last conclusion, one would imagine that, whenever possible, the Cuckoo would insert its egg in the nest when the rightful owners were absent, both to avoid alarming them and meeting with opposition, and thus I rather doubt if heated struggles with the foster-parents are not very exceptional.

There is still one point on which Dr. Rey gives little information:—*What subsequent interest, if any, does the Cuckoo take in her eggs and young?*

He mentions that the Cuckoo has been observed watching the nest for some days afterwards, and that, on occasions, other eggs are removed from the nest subsequently.

I can supply the following data in addition:—

- (a) My late brother, when at school, found a Hedge-Sparrow's nest with a Cuckoo's egg in it, which, luckily, was in the headmaster's garden and secure from molestation. A few days subsequently he heard the Hedge-Sparrows in a great state of alarm and saw a Cuckoo visiting the nest, and on again examining it found that another egg of the foster-parents had been ejected.
- (b) A farmer in Midlothian, who was interested in ornithology and whose word I have no reason to doubt, assured me that he had actually seen a young Cuckoo, in a Meadow-Pipit's nest close to his house, being fed by a Cuckoo.

There is also a case on record of a White Wagtail's nest, built in a fairly deep hole in a tree with a rather narrow entrance, which only contained a young Cuckoo, and as it seemed out of the question for the latter to have ejected the other inmates itself, it must be assumed that the parent had assisted. It thus seems clear that the female Cuckoo, at all events occasionally, does take an interest in the subsequent fate of its egg.

Finally, I once found a Cuckoo's egg in a Hedge-Sparrow's nest, and, on blowing the eggs, discovered that the former was considerably more incubated than the others, which were nearly fresh. This I can only explain by the theory that the Cuckoo at times changes her egg from one nest to another, possibly for reasons of safety.

SUMMARY.

Having, then, dealt with the main theories and conclusions concerning the breeding-habits of the Cuckoo, the results I arrive at are as follows, those based on theory being marked with an asterisk :—

1. *The Cuckoo is probably polygamous.
2. The eggs vary more in colour and markings than those of any known species.
3. Their main distinctive features are the comparatively greater weight, thickness, and strength of the shell.
4. Most Cuckoos' eggs resemble the normal type of those of a certain number of the species which are usually selected as foster-parents ; others are of a "mixed type," intermediate between two such species or of a "distinctive type" of their own. The percentage of eggs *exactly* resembling those of the clutch in which they are found is only about 13 per cent., while those resembling the *general type* of the species in whose nest they are found amount to some 45 per cent.
5. The resemblance occurs most often in the cases of the Common Redstart, Brambling, Whitethroat, Garden-Warbler, Reed-Warbler, Marsh-Warbler, Sedge-Warbler,

and Meadow-Pipit. In all other species it is much more occasional, and it *never* occurs in the case of the Wren, Willow-Warbler, Wood-Warbler, Chiffchaff, and Hedge-Sparrow; yet, of these latter, the first four invariably refuse to hatch the egg, while the Hedge-Sparrow willingly accepts it—a strange fact which is hard to fit in to any theory.

6. In some localities the percentage of eggs resembling the type of the species in whose nests they are deposited is very high, nearly all being similar; in others it is very low. The high percentage usually occurs where one species is mainly used as foster-parent, and the low percentage where several are used.

7. *The explanation of the resemblance of Cuckoos' eggs to the normal type of those of the foster-parents is probably that the nest is selected *after the egg is laid*, and that the female Cuckoo is influenced in her choice mainly by the colour of the eggs in the nest and the resemblance they have to her own. Quite possibly she may also be influenced to some extent by the nest being similar to that in which she herself was reared, especially when she cannot find eggs which match her own. Also she would normally return in spring to the locality in which she herself was reared. Further, when she had once laid, she would know the colour of her eggs and could select nests beforehand if she came across them.

8. *The prevalence of certain distinctive types of eggs in specific localities can be assigned to the law of adaptation. The strain of Cuckoos laying distinctive eggs, *e. g.* blue or very rufous types, would have a large number destroyed, since many species would refuse to accept them and thus this strain would gradually die out except in localities where many nests with similar eggs were to be found. On the other hand, the strain of Cuckoos laying more neutral-coloured eggs would have more young reared, since their eggs would be more easily accepted and thus would flourish in most districts.

9. *Most female Cuckoos return to the same locality as that in which they were themselves reared, and as it may be assumed that their ancestors selected nests whose eggs resembled their own, and that egg-coloration is more or less hereditary, they find suitable nests in such localities. Hence, where several foster-parents are available in one locality, Cuckoos laying eggs of different types will collect, and there is more likely to be a shortage of suitable nests and consequently a lower percentage of resemblance.

10. *The Hedge-Sparrow, which is singularly ready to adopt eggs of any colour, is the favourite "makeshift" foster-parent.

11. *The number of eggs laid yearly is probably nine to twelve.

12. *Laying appears to take place at irregular intervals.

13. *The date of the laying period varies in different localities and corresponds with that of the species selected as foster-parents.

14. *Most Cuckoos lay in the same rather restricted locality.

15. Each female lays eggs of the same type all her life.

16. *The eggs are probably laid on the ground amongst vegetation or in the forks of trees, and at times may be left there with a second or even third egg until suitable nests are found.

17. Only one egg is placed in any nest, and if two or more are found in the same nest they belong to different females.

18. When placing its egg in a nest the Cuckoo usually removes one or more of those of the foster-parent. Occasionally this is done the day before, and at times other eggs are removed subsequently. In the case of the Cow-birds, the eggs of the foster-parents are either ejected or have a minute puncture made in them, either by the beak or sharp claws, so as to prevent their hatching.

19. At times a vigorous resistance is met with from the owners of the nest, resulting in the Cuckoo's egg being destroyed, but usually it is accepted and the young Cuckoo reared with extraordinary devotion by its foster-parents. In this connection it is interesting to learn that some species, such as the Indigo Bunting, will often desert their nests if the Cow-bird's egg be removed, but do not appear to mind the loss of one or two of their own eggs.

20. *Probably the Cuckoo inserts its egg, whenever possible, in the absence of the lawful owners of the nest.

21. Neither the ovary nor the egg-development of the Cuckoo presents any abnormality in comparison to other species.

22. Shortly after being hatched the young Cuckoo ejects all its companions from the nest, and if by chance two young Cuckoos are hatched in the same nest the weaker is ejected. Exceptions occasionally occur, due probably to the nest being in a deep hole, etc., and ejection not being possible.

23. *The female Cuckoo appears, at least at times, to take some interest in the future development of her eggs, subsequently removing other eggs from the nest, and assisting on occasions in the process of ejection and even in feeding her young.

In conclusion, I wish to state clearly that this paper has not been written with any idea of minimising the important results achieved by Dr. Rey and others, who devoted endless labour to trying to throw some further light on this involved question and to whose efforts much of our knowledge is due. My object has been to endeavour to show that the problem is still unsolved and to try to interest others in the subject. The difficulties in obtaining reliable information are so great that it seems that success can only be achieved by united efforts and by ensuring, so far as possible, against any chance clues being lost.

APPENDICES.

As being of interest the following are appended :—

(A) A list of the species breeding in England in whose nests eggs of the Cuckoo have been found.

Species commonly selected as foster-parents :—

Hedge-Sparrow.	Garden-Warbler.	Reed-Warbler.
Meadow-Pipit.	Sedge-Warbler.	Robin.
Tree-Pipit.	Marsh-Warbler.	Pied Wagtail.
Greater Whitethroat.		

Species less commonly selected :—

Blackcap.	Grasshopper-Warbler.	Greenfinch.
Redstart.	Wood-Warbler.	Linnet.
Red-backed Shrike.	Chiff-chaff.	Yellow Hammer.
Lesser Whitethroat.	Grey Wagtail.	Wren.

Species occasionally selected :—

Nightingale.	Twite.	Yellow Wagtail.
Whinchat.	Bullfinch.	Rock-Pipit.
Stonechat.	Goldfinch.	Starling.
Wheatear.	House-Sparrow.	Maggie.
Song-Thrush.	Tree-Sparrow.	Jackdaw.
Blackbird.	Redpoll.	Jay.
Willow-Warbler.	Hawfinch.	Green Woodpecker.
Golderest.	Spotted Flycatcher.	Ring-Dove.
Great Titmouse.	Pied Flycatcher.	Stock-Dove.
Skylark.	Swallow.	Turtle-Dove.
Woodlark.	Corn-Bunting.	Little Grebe.
Chaffinch.	Tree-Creeper.	Long-tailed Titmouse (doubtful).

Cuckoos' eggs have altogether been found in the nests of over 120 different species.

(B) Further data regarding the nesting-habits of the Cow-birds of America.

Major Bendire gives the following instances of mistakes and imperfections in the procreant instinct of the Cow-birds :—

(1) The eggs are sometimes dropped on the ground and wasted.

(2) They are placed in forsaken nests.

(3) They are laid after incubation of the eggs has begun.

(4) One female lays several eggs in the same nest.

(5) Several females lay in the same nest.

(6) The male and female of some species destroy their own eggs by picking holes in them and sucking the contents.

On the other hand, he says that their eggs possess the following advantages :—

(1) The vitality of the embryo is very great and it survives after the other eggs in the nest have become addled, and eggs buried in the lining of nests have been found with the young ready to hatch, though as the young in the nest itself were some fourteen days old the Cow-bird's egg must have been about six weeks old and probably was incubated by the heat of the other young.

(2) They are usually larger and have a harder shell.

(3) They take only some eleven and a half days to hatch as against fourteen to sixteen days in the case of other similar species, and consequently have a chance if deposited in nests in which the other eggs are incubated.